

Case Study:

Stress Tolerant Varieties of Rice

17 Aug 2017

Suniyom Taprab

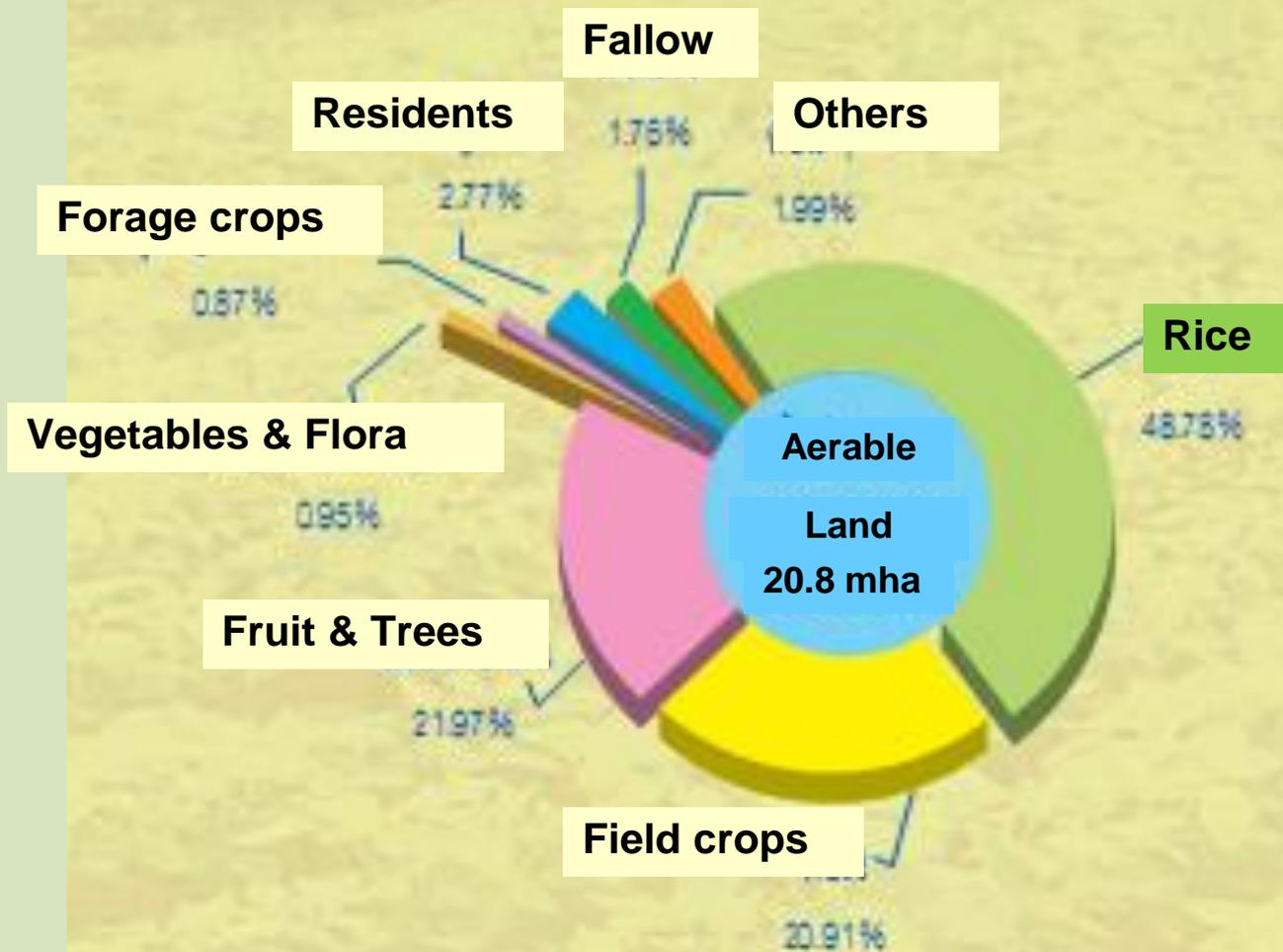
Rice Department, MOAC

Bangkok

Introduction:

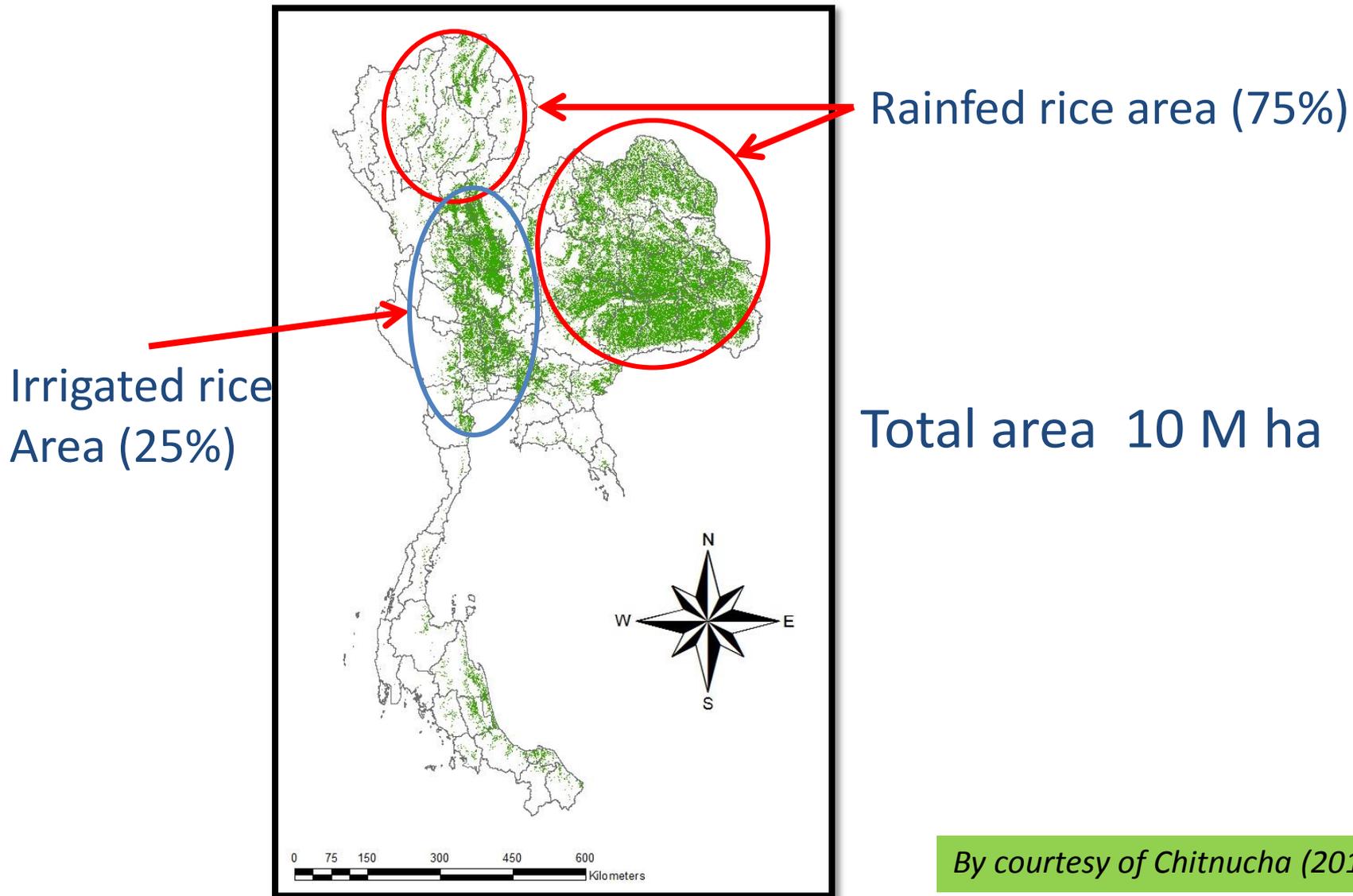


Land Used



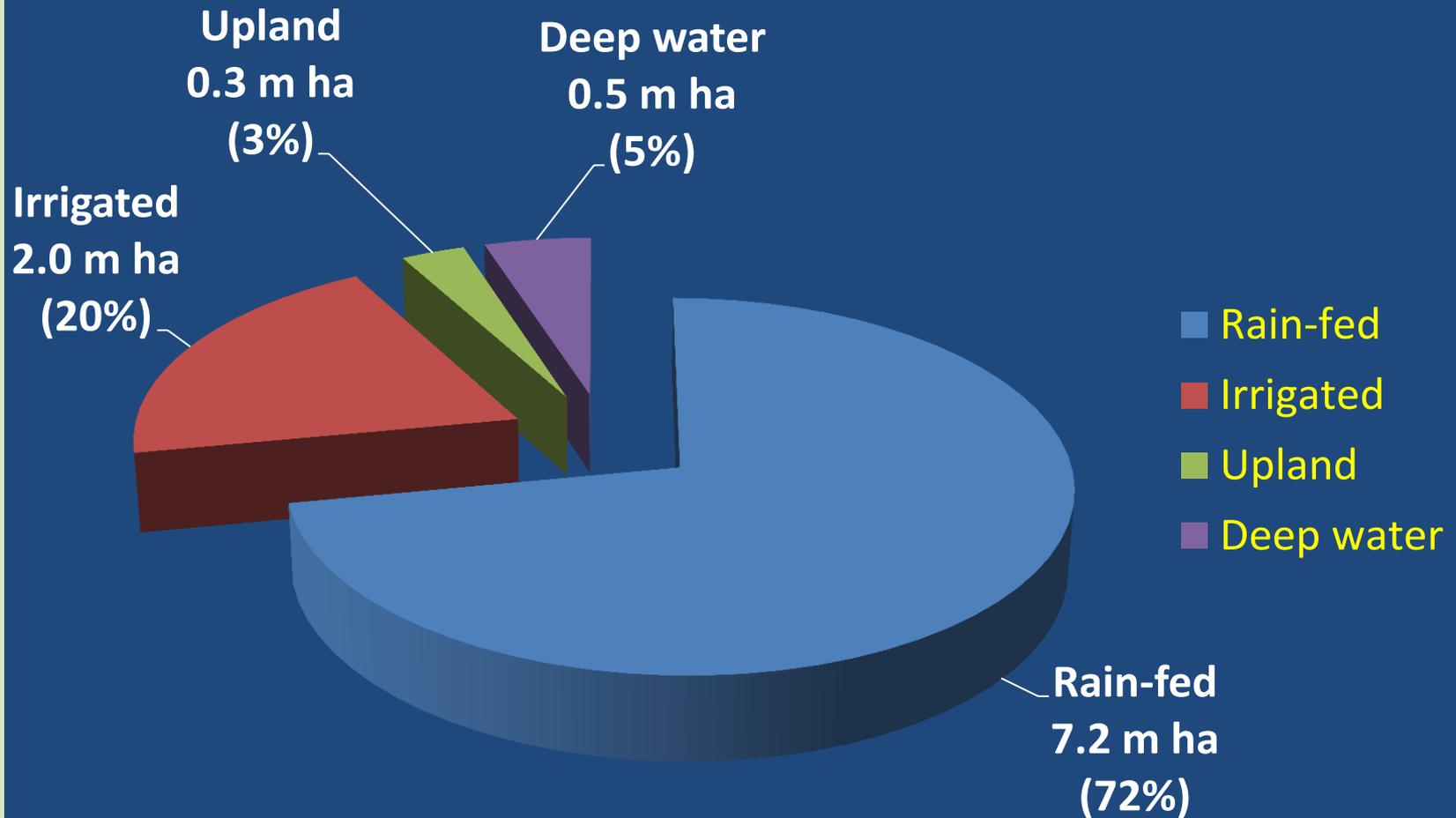


Rice area map of Thailand



By courtesy of Chitnucha (2017)

Rice area (million ha) in 4 sub-ecosystems



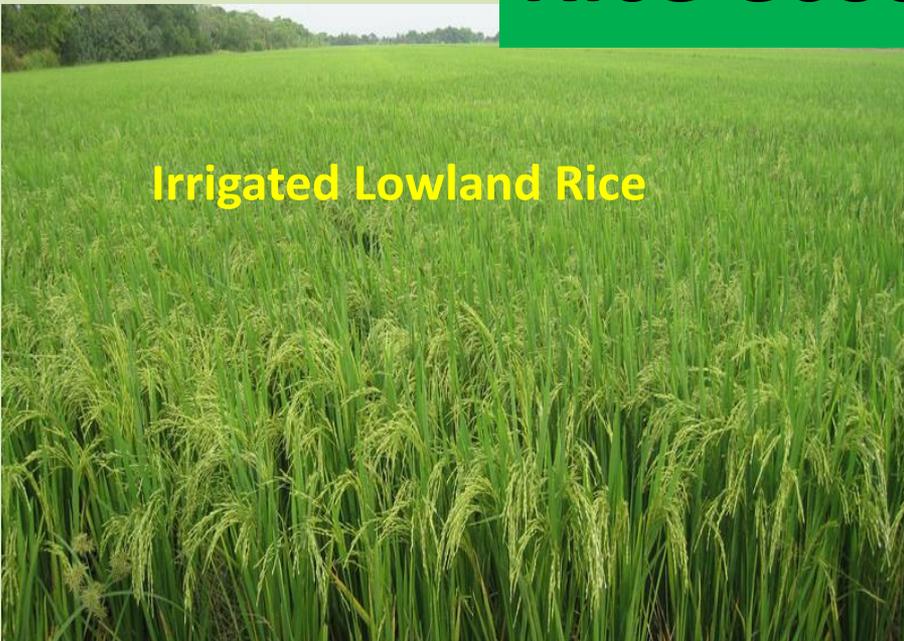


Upland Rice

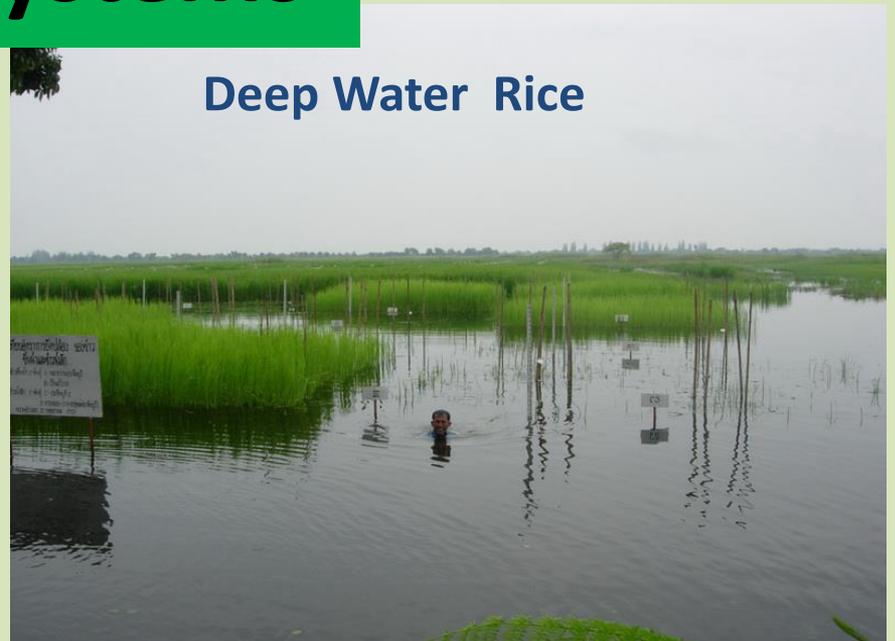


Rain-fed Lowland Rice

Rice ecosystems



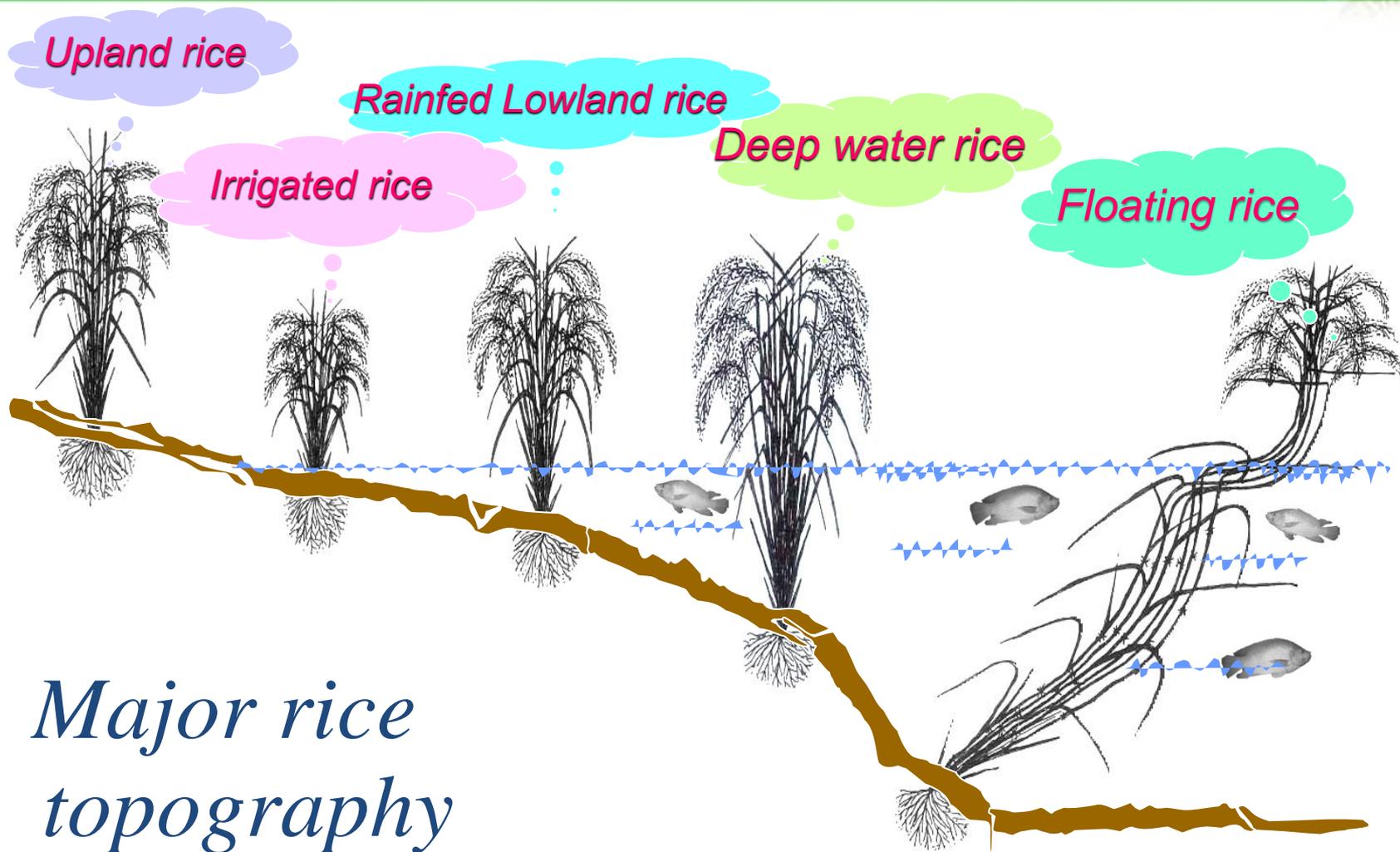
Irrigated Lowland Rice



Deep Water Rice



Introduction



Major rice topography

Adapted from Chitnucha (2017)

CROPPING SEASONS : and Major Type of Cultivated Rice Variety

- **Wet Season** (Major rice)

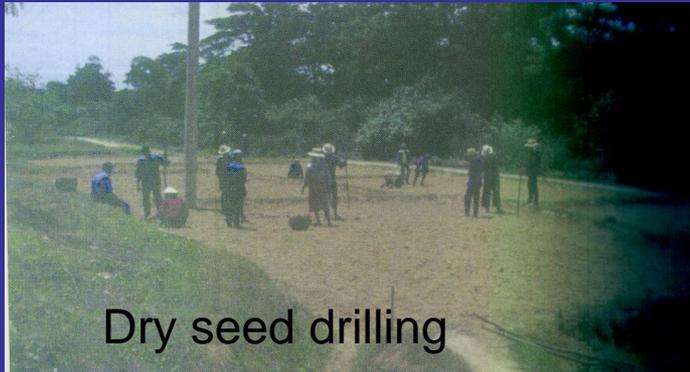
July ~ November

Photoperiod sensitive varieties

- **Dry Season** (Second rice)

January ~ May

Photoperiod insensitive varieties



Dry seed drilling



Dry seed broadcasting

Dry seed drilling by machine

Planting Practices



Pre-germinated seed broadcasting

การทว่านน้ำตม



Transplanting



Dry seed broadcasting

นาข้าวขึ้นน้ำ

Transplanting Machine



ปัจจุบันนิยมใช้เครื่องหยอดเมล็ด ทั้งแบบแห้ง และแบบเปียก



Combined Harvester

Stresses:

Abiotic stresses – Water, Soil, Temperature

Biotic stresses – Diseases, Insect pests

Climate change induce water stresses e.g. drought and flood, because of uneven rainfall distribution.



Fig. Flooding during flowering stage of rain-fed rice

Fig. Drought during vegetative stage of rain-fed rice



Water shortage in irrigated rice production area



Research Schemes of Rice Dept. :

1. Increasing yield potential and production efficiency
2. Reducing yield losses and stabilizing yield
3. Retaining high grain quality
4. Climate change adaptability and mitigation

5. Self-sufficient rice production for food security in specific area

6. Value adding and special rice for niche market

7. Low production cost technology

Abiotic Stress Tolerant Varieties:

I. Drought

Genotypic :

Complicated

Quantitative Trait Loci (QTLs)

Phenotypic :

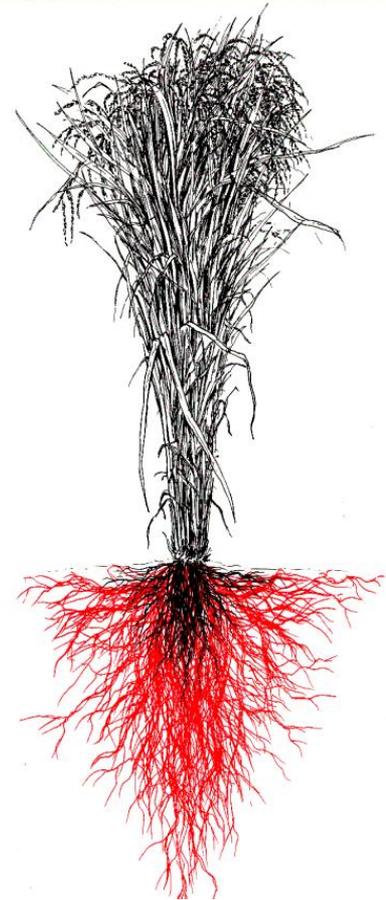
Shoot, Root

Physiological :

Evapotranspiration

Leaf Water Potential

Leaf Temperature

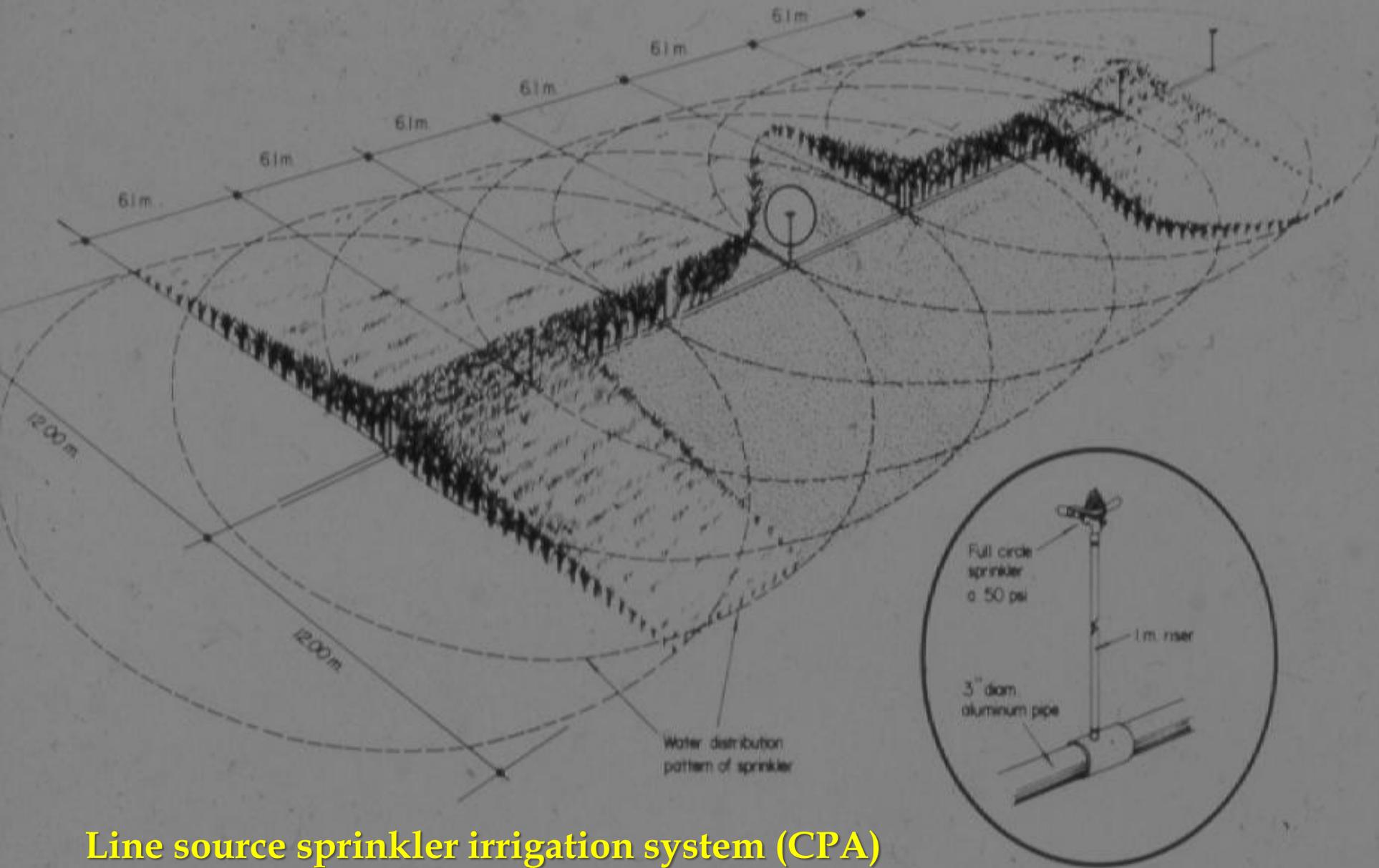


Phenotypic characterization of drought avoidance and drought tolerance traits in selected KDML105 chromosome segment substitution lines (CSSL) harboring full QTL segment under field experiments



By courtesy of Suwat (2017)

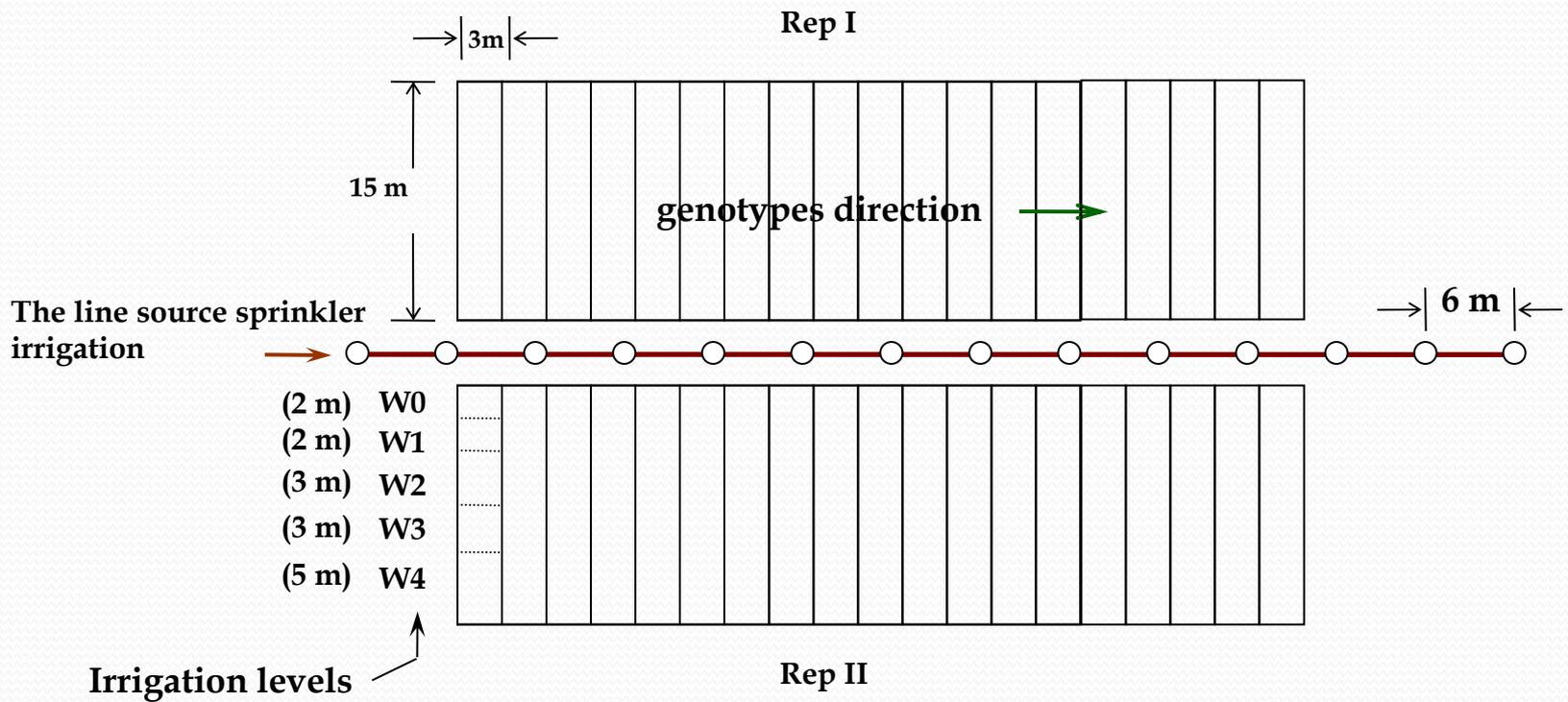
Presented in the meeting at Sakon-Nakhon Rice Research Center
2 March 2013



Line source sprinkler irrigation system (CPA)

By courtesy of Suwat (2017)

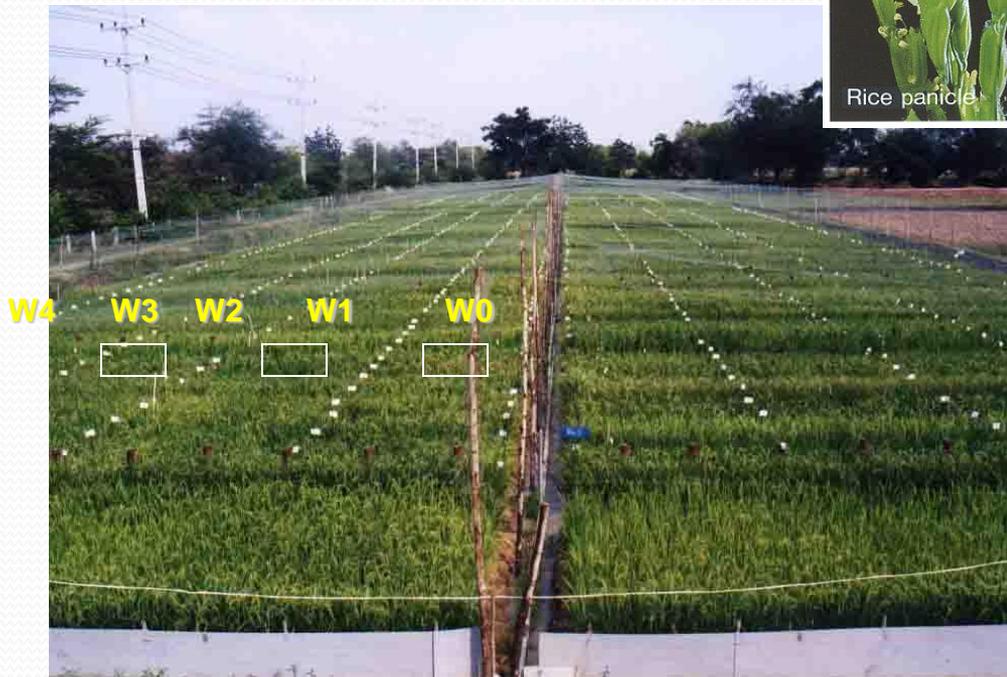
Field layout



Data collections



Flowering date, Visual score and Panicle exertion rate



Grain yield and Yield components



Predawn LWP
(24:00 - 03:00 am)



Midday LWP
(12:00 - 15:00 pm)

Drought score



Score 1



Score 3



Score 5



Score 7



Score 9

Leaf rolling score



Score 1



Score 2



Score 3



Score 4



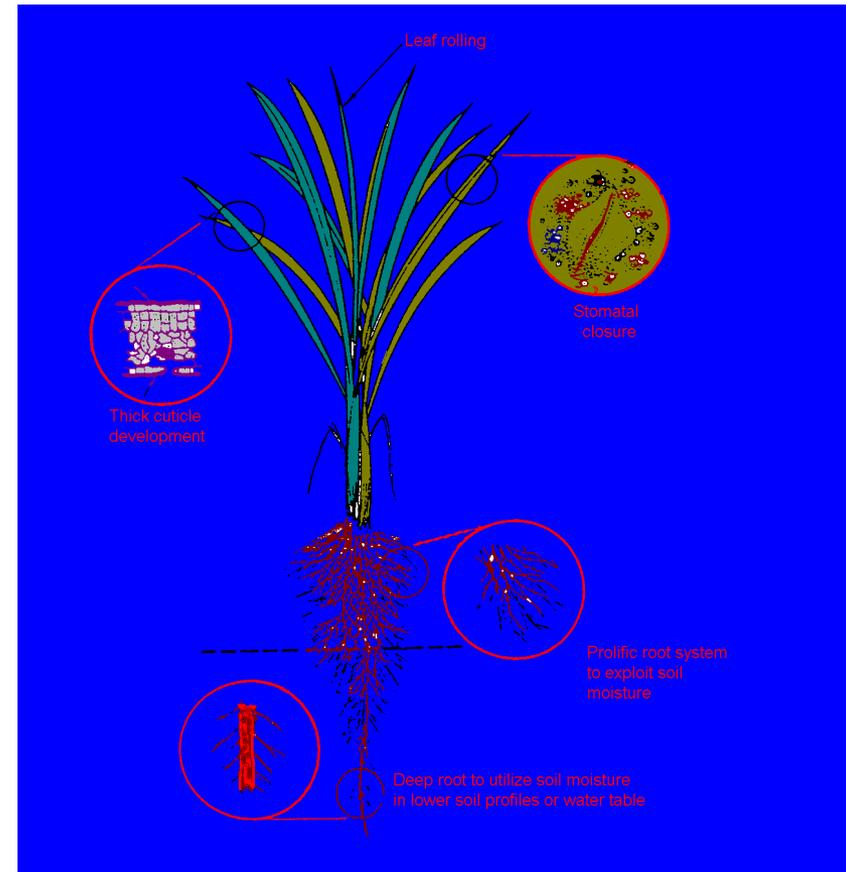
Score 5

Severity of Drought at CPA

	Grain yield (kg/rai)	Irrigation level
<i>Yield loss > 50%</i> <i>(Severe stress)</i>	21 	W4 (severe stress)
<i>Yield loss > 50%</i>	172 	W3 (severe stress)
	456 	W0 (well water)

Drought resistance mechanisms (Mackill *et al.*, 1996)

- Root-related traits :
 - Deeper and denser root system
(*Increased water uptake*)
- Shoot-related traits :
 - Stomatal closure, leaf rolling, thicker epicuticular wax,
osmotic adjustment
(*Maintenance leaf water potential and turgor potential*)
- Reproductive stage specific :
 - Increase panicle diffusive resistance,
early morning anthesis
(*flower at higher panicle water potential*)
 - Emergence of new panicles from internodes
(*Recovery of lost yield component*)
 - **Remobilization and translocation of stored reserves**
(*Maximization of potential harvest index*)



Root Morphology

related to drought tolerance

- Root length or depth
- Lateral root branching
- Root angle
- Root hairs
- Root aerenchyma

Genotyping rice chromosome segment substitution lines to facilitate gene discovery for root characteristics



By courtesy of Panchita (2017)



Harvest at 60 days after sowing.



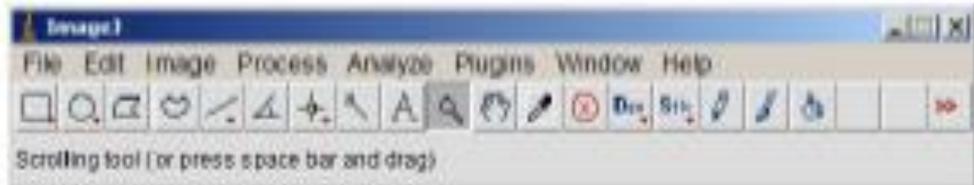
By courtesy of Panchita (2017)

Significant phenotypic variation of lateral root branching



By courtesy of Panchita (2017)

Quantitative Analysis of Root Hair Traits

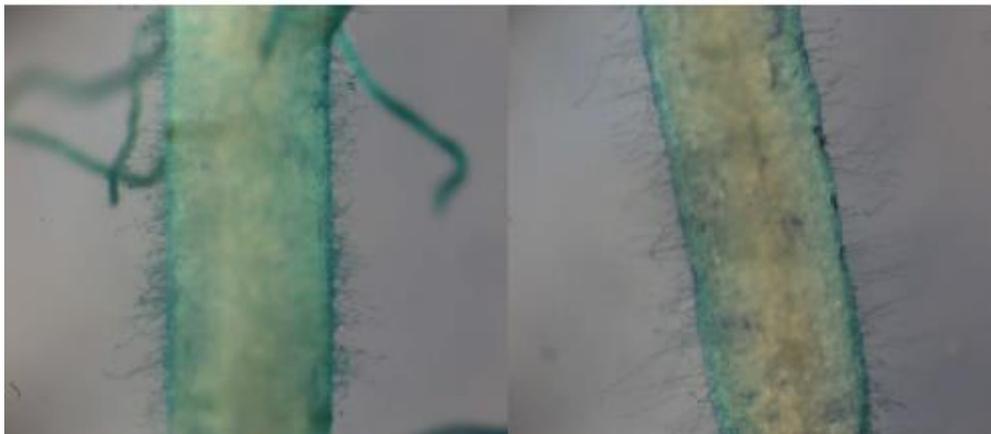


By courtesy of Panchita (2017)

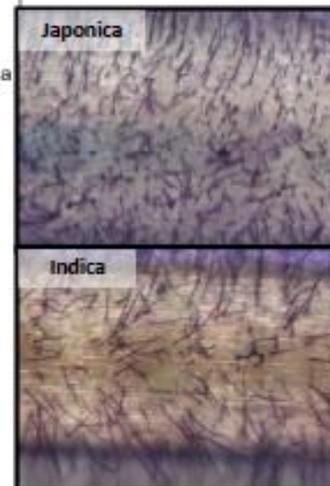
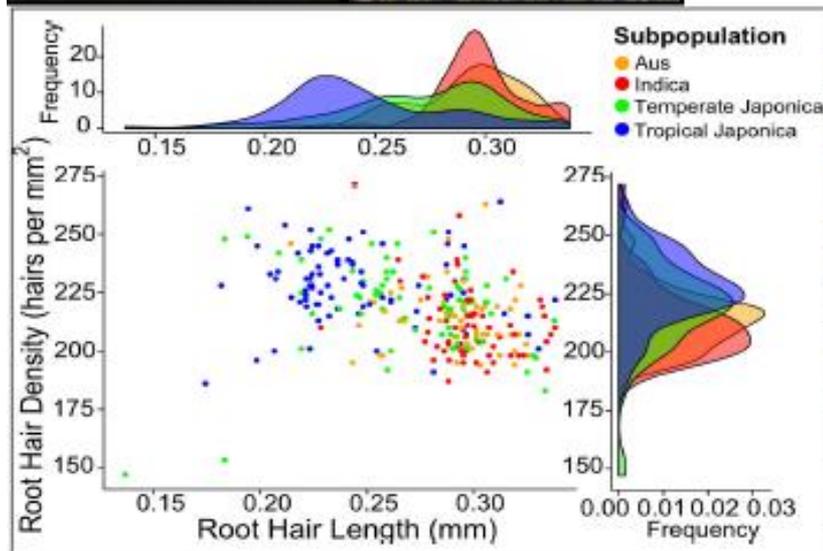
Substantial phenotypic variation in root hairs has been observed.

CSSL 45

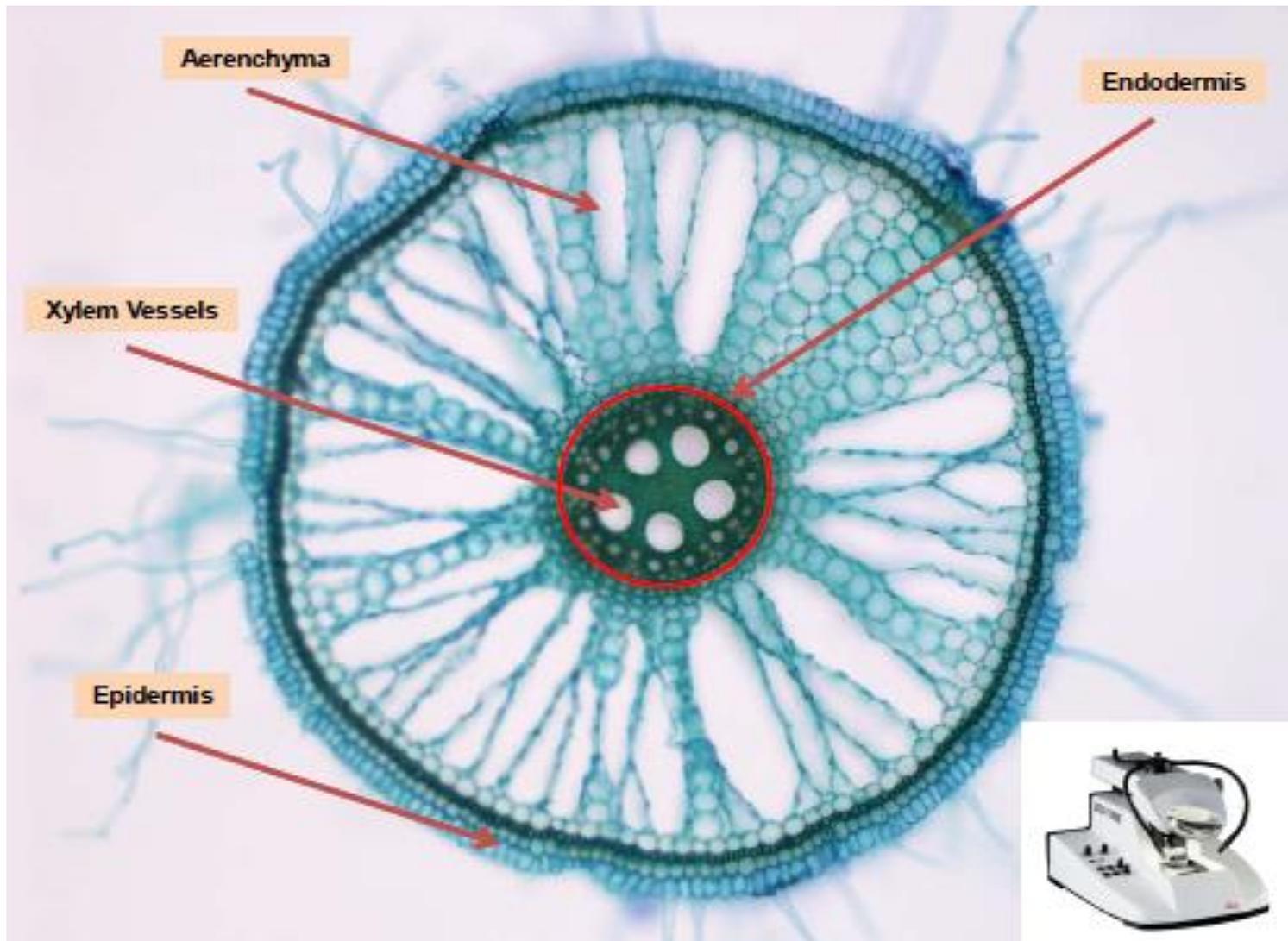
CSSL 9



Root hair length and density vary independently among genotypes in rice.



By courtesy of Panchita (2017)



Root aerenchyma

Abiotic Stress Tolerant Varieties:

II. Flood and Submergence

น้ำท่วมมี 2 แบบ คือ

1. น้ำท่วมซ้ำซาก (Repetitious flood)
2. น้ำท่วมฉับพลัน (Flash flood)

Tolerant Varieties :

1. Deep-water rice, Floating rice
(Stem elongation ability)
2. Submergence tolerant



Deep-water rice

Stem
elongation
ability

Floating rice



Plai Ngahm Prachinburi (PGM)

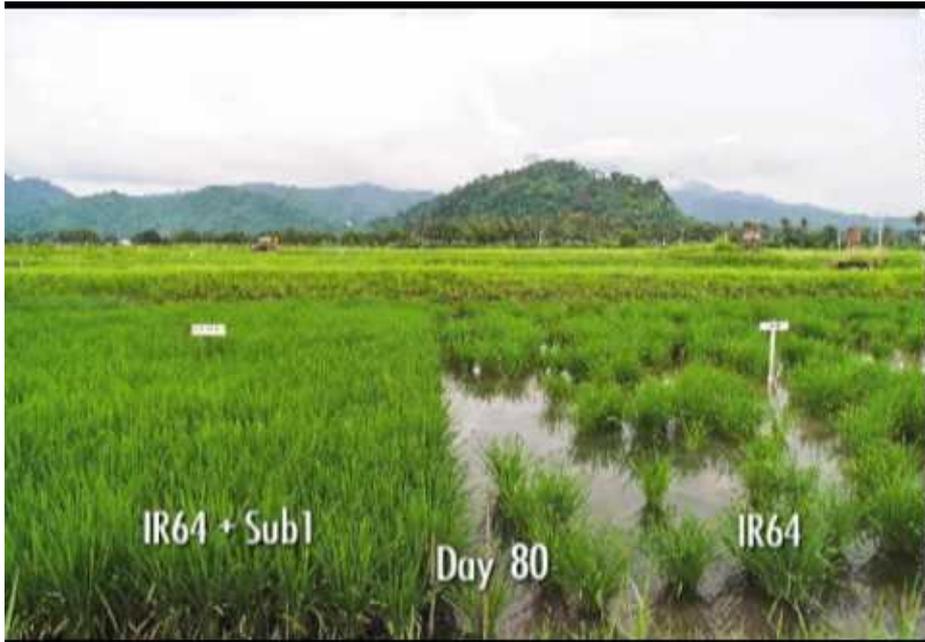




ศูนย์วิจัยข้าวปราจีนบุรี สำนักวิจัยและพัฒนาข้าว กรมการข้าว กระทรวงเกษตรและสหกรณ์

Submergence tolerant varieties :
IR64-sub1, Swarna-sub1, กข51 (RD51)



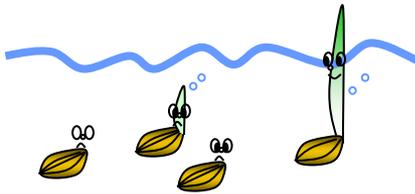


Flood affected (10 d submergence) rice fields of Arun Kumar Singh at village Khuruhuja, District Chandoli, UP, India

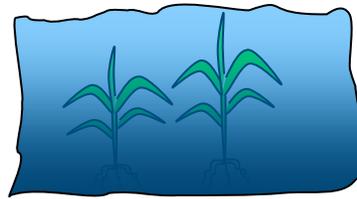


Rice Mutation Breeding To Cope with Climate Change

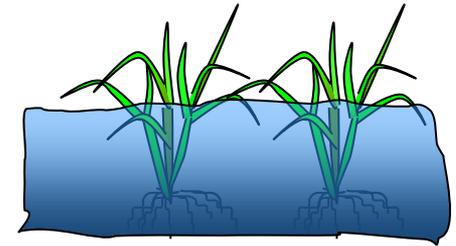
I. Flooding Conditions



**Anaerobic
germination
ability**



**Submergence
tolerance**



**Elongation
ability**

Currently conducting Mutation Breeding

Screening for submergence tolerant lines





Flooding



By courtesy of Peera (2017)



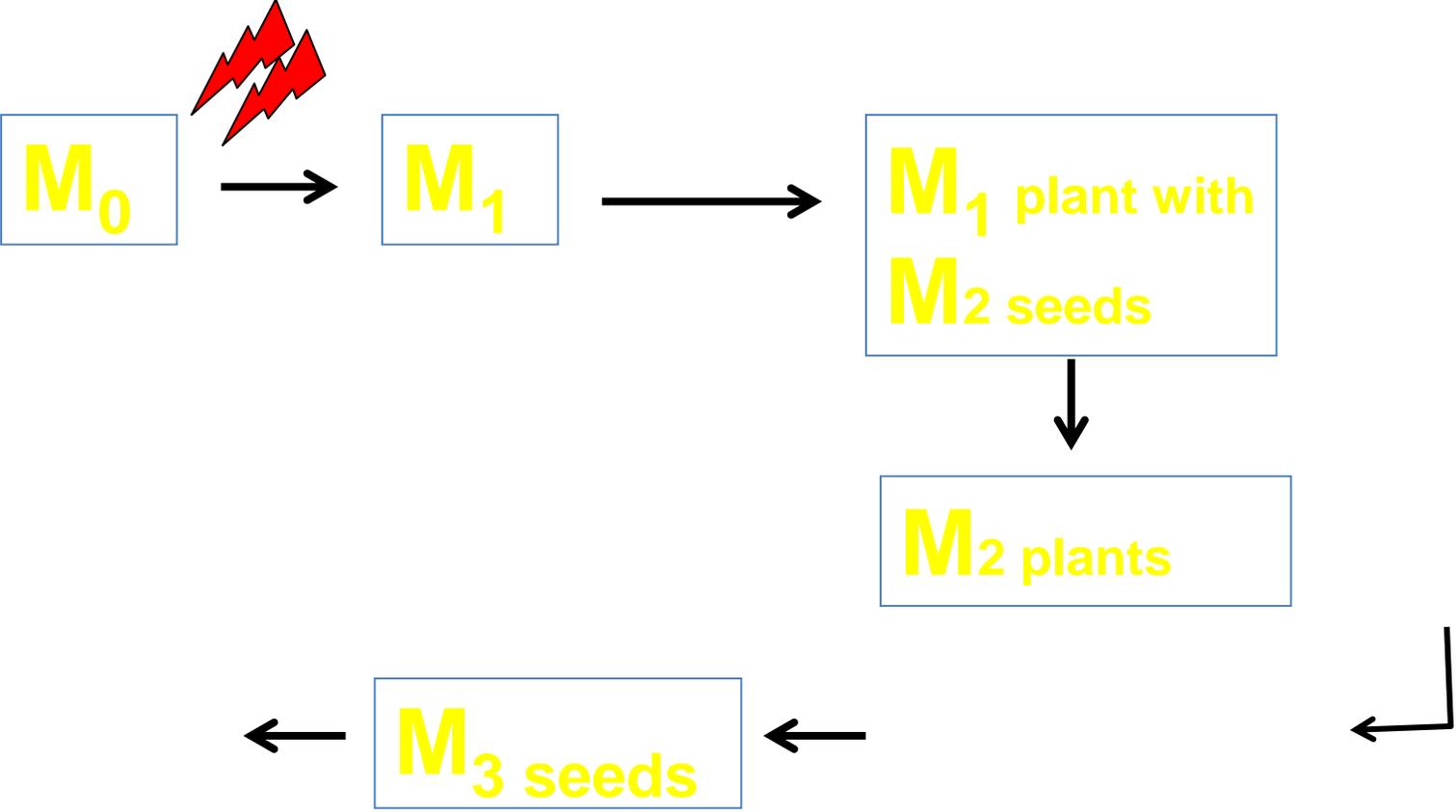
Draining

By courtesy of Peera (2017)



Recovery

By courtesy of Peera (2017)



Screening for anaerobic germination seed



1 day after submerge



21 day after submerge

Before submergence



14 days submerge



Recovery period (20 days after de-submerge)

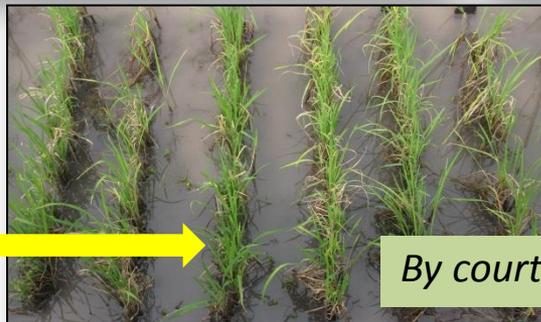


2 days after de-submerge

Submergence recovering evaluation



การทดสอบความสามารถทนน้ำท่วมฉับพลัน



By courtesy of Udompan (2017)

สรุปผลการทดลอง



I am flood tolerant.



- IRR119-PCR-162: ข้าวทนน้ำท่วมในระยะแตกกอ ได้นาน 10-15 วัน ในสภาพ
บ่อทดลองและพื้นที่จริงได้ 85-95%

กข25 (462 กก./ไร่) ร้อยละ 56



- ลักษณะทางกายภาพ/เคมี
ข้าวกล้องสีข้าว ยาว 8.11 มม. กว้าง 2.36 มม. หนา 1.95 มม. รูปร่างเรียวยาว ท้อง
ไข่มาก 2.12 อมิโลสสูง 27.45%
- ปฏิกริยาต่อโรค/แมลง : ค่อนข้างอ่อนแอ BI, BPH, GLH, ค่อนข้างอ่อนแอ-ปาน
กลาง WBPH

By courtesy of Udompan (2017)

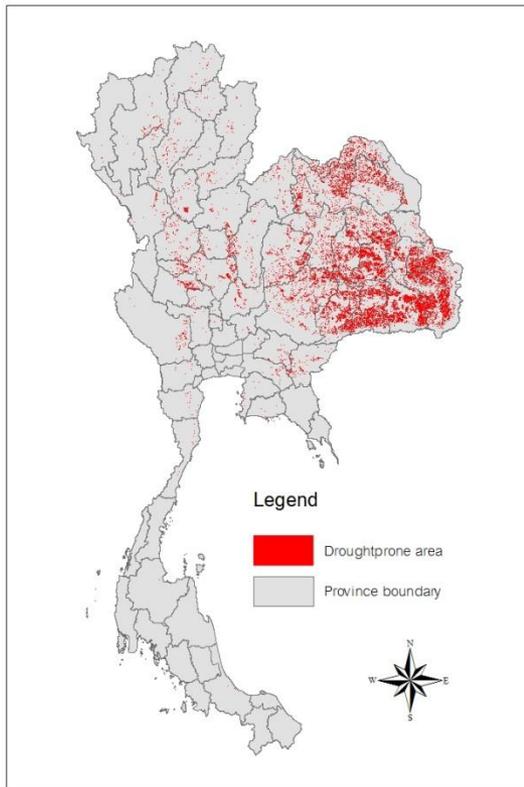
Abiotic Stress Tolerant Varieties:

III. Adverse soil

- Salinity(2.7 m Ha)
- Acidity(1.2 m Ha)

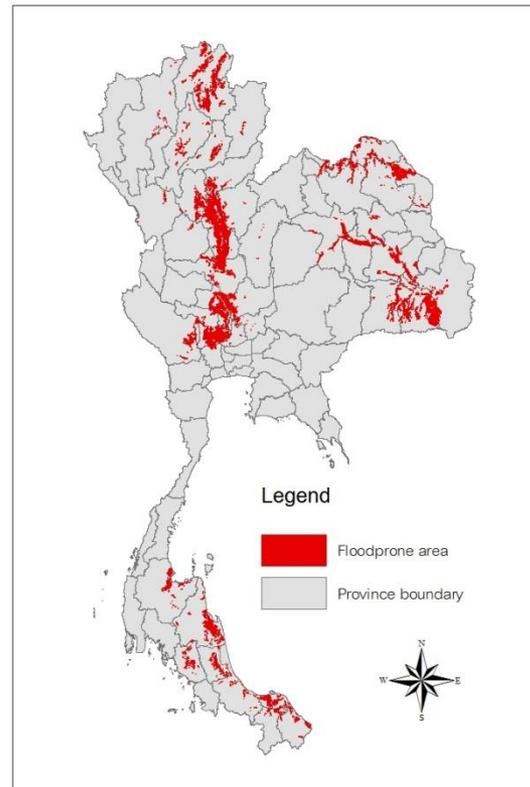
Environment and climate condition

Drought-prone area



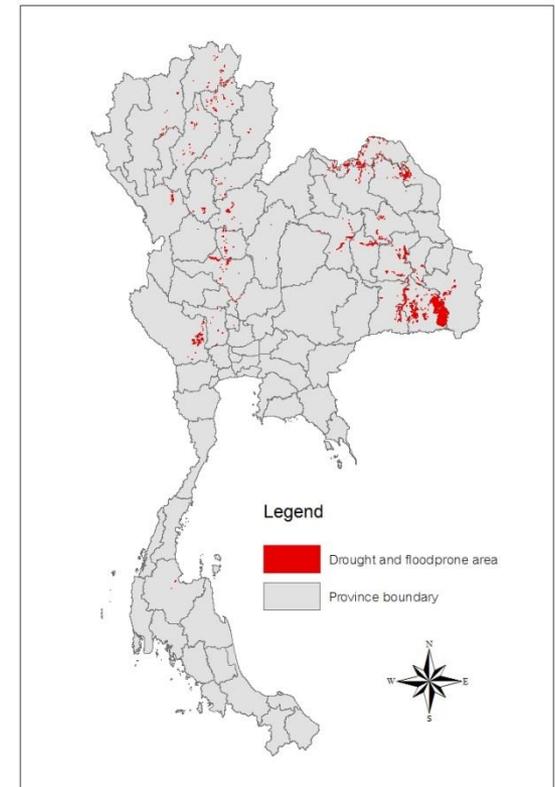
3,910,621 ha

Flood-prone area



916,292 ha

Drought and flood-prone area



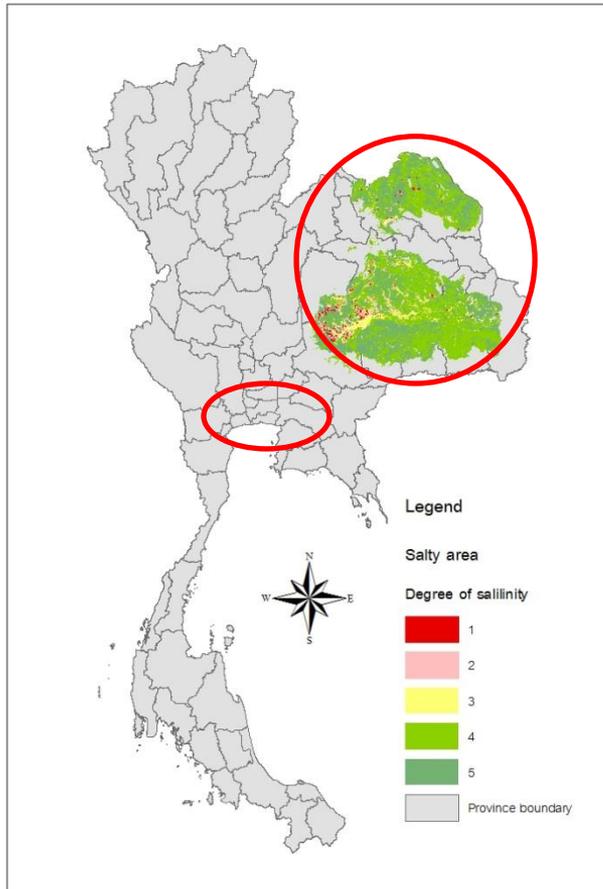
77,271 ha

By courtesy of Chitnucha (2017)

แหล่งที่มา: กรมพัฒนาที่ดิน

Adverse Soils

Salinity stress



By courtesy of Chitnucha (2017)



By courtesy of Duangjai (2017)

Salt tolerance
genetic :

QTLs “ Saltol ”
cchromosome 1

Genes:

SOS1 – Na⁺

SKC1 – K⁺

Donors:

Pokkali

Nonabokra

IR66946



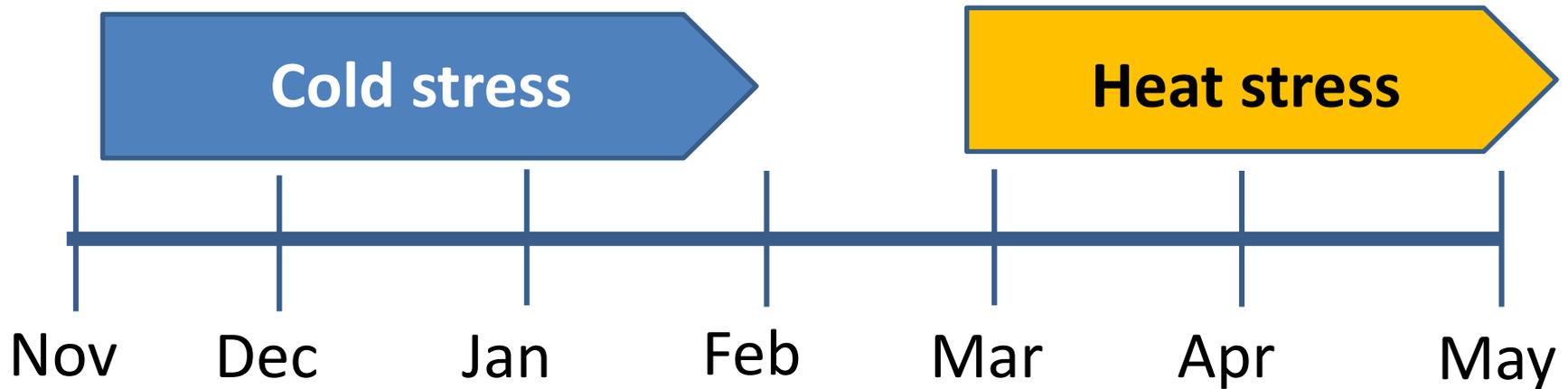
พันธุ์ กข73

By courtesy of Duangjai (2017)

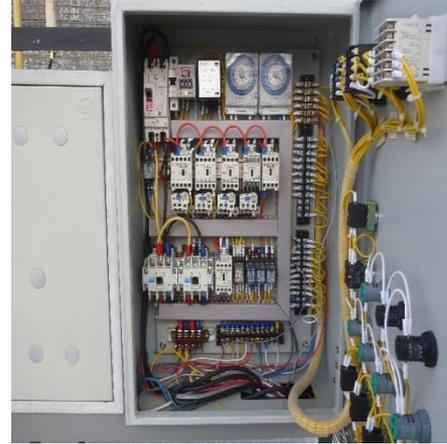
Abiotic Stress Tolerant Varieties:

IV. Temperature

- Heat stress (High temp.)
- Cold stress (Low temp.)



โรงเรือนจำลองสภาพอุณหภูมิสูง



ศูนย์วิทยาศาสตร์ข้าว ม.เกษตร
กำแพงแสน นครปฐม

By courtesy of Peerapol (2017)

The most critical period of high temperature on the yield of rice.



Growth and tillering.



The most critical period of high temperature on the yield of rice.

(Matsui and Omasa, 2002)

By courtesy of Peerapol (2017)

Materials and Methods



By courtesy of Peerapol (2017)

Anther character of heat treatment



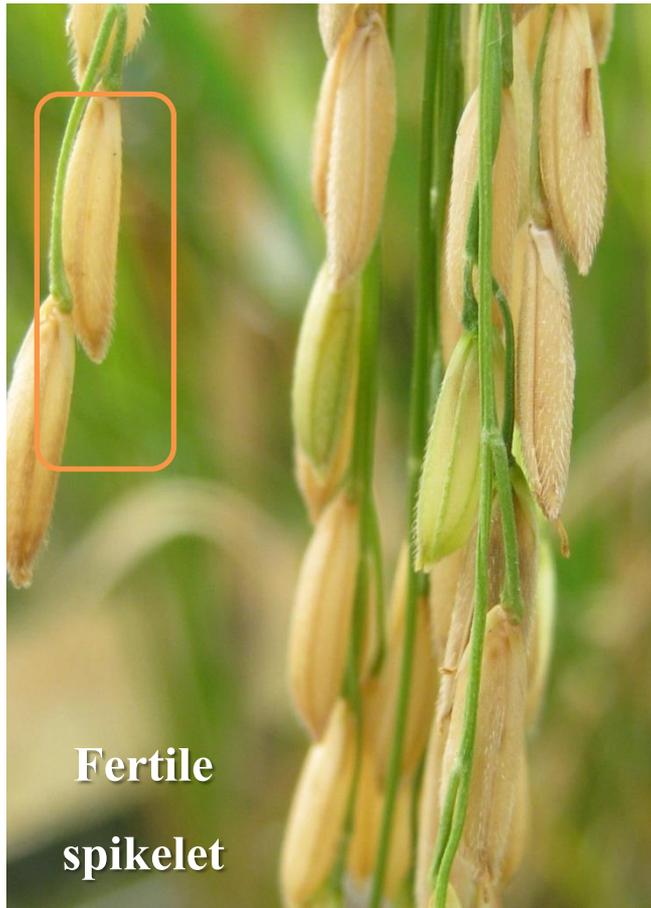
high temperatures **tolerance**



high temperatures **sensitive**

By courtesy of Peerapol (2017)

Spikelet character of heat treatment



high temperatures **tolerance**



high temperatures **sensitive**

By courtesy of Peerapol (2017)



THANK YOU